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United States Government 0047066 Department of Energy

memorandum

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REPLY TO ATTN OF: RW-30

SUBJECT: Repository Disposal Fee Estimates for the Hanford Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS)

TO: Jackson Kinzer, Assistant Manager
Office of Tank Waste Remediation System

The Office of Civilian Radioactive Waste Management is pleased to transmit the information to address your request for disposal fee estimates to support the development of the Hanford TWRS EIS. This responds to your June 7, 1996, request for more rigorous cost estimates based on application of our Total System Life Cycle Cost (TSLCC) methodology. We have completed an analysis for the following four alternative scenarios and compared them against the 1995 TSLCC baseline:

1. Use of 23,000 "standard" canisters for the most probable quantity (14,260 m^3) of immobilized HLW for the reference "enhanced sludge wash" process.

2. Use of 12,200 "long" 0.61m D x 4.5m L canisters for the most probable quantity of Hanford HLW.

3. Use of 530 "long" canisters for 620 m^3 of HLW resulting from the "extensive separations" pretreatment process.

4. Use of 36,400 "very large" 1.68m D x 5.03m L canisters for 364,000 m^3 of HLW produced without any pretreatment.

Results of the analysis, including key assumptions, significant cost drivers, and limitations on the cost calculations, are provided in the attachment entitled "Cost Estimate Report on Disposal Costs for Tank Waste Remediation System Alternatives". It must be pointed out that the results presented are consistent with the assumptions documented in the 1995 TSLCC. In this regard, scenario 4 is so significantly outside the range of these assumptions that there may be other implications, beyond the large cost increase projected for disposal, which could affect our ability to license a repository or implement emplacement within the currently envisioned disposal system.

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We appreciate the opportunity to assist you in the completion of the Hanford TWRS Final EIS. Please feel free to contact James Carlson of my staff at (202) 586-5321, if you have any questions regarding the report.

Ronald A. Milner

Ronald A. Milner, Director
Office of Program Management
and Integration
Office of Civilian Radioactive
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Attachment

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WBS: 8.2.1
QA: N/A

Civilian Radioactive Waste Management System
Management & Operating Contractor

Cost Estimate Report on Disposal Costs for Tank Waste Remediation System Alternatives

June 28, 1996

WBS: 8.2.1
QA: N/A

Civilian Radioactive Waste Management System
Management & Operating Contractor

Cost Estimate Report on Disposal Costs for Tank Waste Remediation System Alternatives

June 28, 1996

Prepared for:

U.S. Department of Energy
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1. SUMMARY

This analysis was performed at the request of the Department of Energy Richland Operations Office to support analysis of alternatives for the TWRS as part of the development of the TWRS Environmental Impact Statement (reference 1, see Appendix A). Estimates of disposal costs were developed for four alternatives for the Hanford Tank Waste Remediation System (TWRS). Estimates of the total defense share of disposal costs were generated using a consistent methodology, as used by the Civilian Radioactive Waste Management Program in development of the Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program of September 1995 (95 TSLCC) (reference 2). Technical feasibility and the environmental effects of disposal are not within the scope of this study and are not addressed. Costs are presented in constant 1994 dollars to maintain consistency with the 95 TSLCC.

The 95 TSLCC base case and TWRS alternatives analyzed in this study are summarized in Table 1-1. The TSLCC assumed 9,860 standard canisters from Hanford would be disposed of in the repository. Scenario 1 would require disposal of 23,000 standard canisters from Hanford. Scenario 2 is based on the same volume of glass as Scenario 1, disposed of as 12,200 "long canisters" (4.5 meters in length versus 3.0 meters for the standard canisters). Scenario 3 assumes extensive separations resulting in less glass volume, to be disposed of as only 530 long canisters. Scenario 4 assumes 36,400 very large 10 cubic meter canisters are used to dispose of the very large volumes of vitrified waste which could result from a "no pretreatment" TWRS alternative.

Summary results are presented in Table 1-1. Each of four Hanford TWRS alternative scenarios are compared against the baseline assumed for the 95 TSLCC. Total Disposal Cost for the 95 TSLCC base case is $33.1 billion in constant 1994 dollars (94$s). The first three alternatives would result in a small variation in Total Disposal System Costs. Scenario 3 would save $0.5 billion (94$s) or 1.4 percent. Scenario 2 would increase Total Disposal System Costs by $1.4 billion (94$s) or 4.2 percent, and Scenario 1 would increase costs by $2.0 billion (94$s) or 6.0 percent. Scenario 4 would double the Total System Disposal Cost to over $66 billion (94$s) or 100 percent.

Scenario 1 has been identified by the TWRS program as the most likely current estimate of borosilicate glass canisters to be produced. Scenario 1 poses the disadvantage, from a disposal standpoint, of utilizing most available space between Spent Nuclear Fuel (SNF) waste packages. This could limit growth capacity to accept other wastes being considered for disposal, such as DOE SNF.

Scenario 4 is not a preferred alternative from a disposal standpoint. Scenario 4 would not only double the Total System Disposal Cost to over $66 billion (94$s), it would require approximately 35 additional years of geologic emplacement and extension of the planned disposal program

Table 1-1 Repository Disposal Cost Evaluation Matrix

	Canister Size (OD x L)	Pretreatment Process	Volume of Glass, m^3	Number of Hanford Canister	Total No. of DHLW Canisters	Total Disposal Cost (94$s)	Allocated Defense Share (94$s)
Base Case (RW-0479)	0.61m x 3.0m	Enhanced Sludge Wash	6,100	9,860	18,046	$33.1B	$6.43B
Scenario #1 (most probable volume)	0.61m x 3.0m	Enhanced Sludge Wash	14,260	23,000	31,186	$35.1B	$10.3B
Scenario #2 (long canister)	0.61m x 4.50m	Enhanced Sludge Wash	14,260	12,200	20,386	$34.5B	$8.6B
Scenario #3 (minimum volume)	0.61m x 4.50m	Extensive Separations	620	530	8,716	$32.6B	$4.0B[1]
Scenario #4 (very large canister)	1.68m x 5.03m	No Pretreatment	364,000	36,400	44,586	$66.2B[2]	$49.3B[2]

1 Share methodology understates defense share of unassigned costs due to extremely low piece counts. Actual share will be higher.

2 Scenario significantly in excess of repository planning basis. Requires assumptions which increase uncertainty of estimate. Scenario outside methodology validity for piece counts and disproportional waste package size.

completion from an assumed decommissioning in 2071 to 2102. Further, it would require characterization of additional area, suitability determination of the area, and associated licensing of a Hanford only section of the repository. A substantial portion of the Hanford wastes would require emplacement in the additional areas in a low thermal setting, following emplacement of some Hanford and all other HLW with all the available SNF in a high thermal setting in the primary area of the repository. This is in contrast to the 95 TSLCC assumption of emplacement of all HLW with SNF in the primary area in a high thermal loading setting. Excess quantities of Hanford HLW may exceed available areas in the repository. Disposition of remaining HLW would not be decided until DOE makes a recommendation on the need for a second repository.

The last column in Table 1-1 shows an estimate of the total defense share of each alternative. Estimates range from a reduction of $2.5 billion for Scenario 3 to an increase of $43 billion for Scenario 4. Estimates of defense share in Table 1-1 do not represent firm estimates of the full cost recovery for disposal of defense high level waste. The cost sharing allocation methodology was developed for a point estimate and design. Extreme case variations such as Scenario 3 and 4 fall outside the validity of the computational method. Differences between the cases appear to be exaggerated by the defense share allocation methodology bias.

2. SCOPE

This analysis was performed at the request of the Department of Energy Richland Operations Office to support analysis of alternatives for the TWRS as part of the development of the TWRS Environmental Impact Statement. The analysis was developed under an accelerated schedule, and of necessity provides scoping level detail, scaled from the detailed point estimate reported in the 95 TSLCC. It provides life cycle cost estimates for four alternative scenarios for disposal of vitrified high level waste (HLW) from Hanford. Scenarios vary HLW quantities and package sizes from the 95 TSLCC estimate basis. The scenarios and approach are described in Section 3. The analysis includes estimates for two new HLW waste packages, two new transportation casks, and estimates of changes to repository surface facilities, subsurface impacts, transportation, and other program costs.

Estimates of the total defense share, based on application of the 1987 Federal Register methodology, are provided in Section 4. Two cases, Scenarios 3 and 4, depart significantly from the base case. For these scenarios, quantitative estimates are provided, with qualitative discussion of impacts and limits of the analysis. Analyses are based on and consistent with the 1995 TSLCC.

A Hanford Multi-Purpose Canister (HMPC) is being considered by DOE for on-site storage at Hanford, followed by transportation to and disposal in a repository. An HMPC would be an overpack canister 4.65 meters in length by 1.61 meters outside diameter, sized to contain four of the long Hanford canisters of vitrified HLW such as those assumed for Scenarios 2 and 3 in this analysis. For transportation, each HMPC would be placed in a transportation overpack for shipment. At the repository, the unopened HMPC would be transferred to a disposal overpack, which, combined with the HMPC and its contents would comprise a four canister waste package. It is assumed that the HMPC would be licensed for storage, transportation, and disposal. The 95 TSLCC was not based on use of the HMPC. A qualitative discussion of the impacts of possible use of an HMPC is included.

3. APPROACH

3.1 TSLCC BASELINE

The 95 TSLCC forms the baseline for comparison of disposal costs for alternatives, and for estimation of the defense share for each alternative. The TSLCC assumes 9,860 standard canisters of HLW from Hanford are disposed of with 8,186 canisters of HLW from other DOE sites and the West Valley Demonstration Project, comingled with waste packages containing approximately 84,000 metric tons of Uranium (MTU) of commercial spent nuclear fuel (SNF). The 95 TSLCC does not include other wastes being considered for inclusion in the Civilian Radioactive Waste Management System (CRWMS), such as DOE SNF. The 95 TSLCC assumes disposal in a single repository, with the Yucca Mountain site in Nevada serving as a surrogate to allow estimation of total system life cycle costs. The Nuclear Waste Policy Act as Amended (NWPAA) (reference 3) establishes a 70,000 Metric Tons of Heavy Metal (MTHM) limit on a first repository, tied to opening of a second repository, and also specifies that the need for a second repository will be assessed between 2007 and 2010. This analysis assumes disposal in a single repository, consistent with the 95 TSLCC assumptions. Design concepts in the 95 TSLCC assume emplacement of waste packages, containing four HLW canisters each, in the spaces between SNF waste packages, in a spacial arrangement with a high thermal load. The 95 TSLCC assumptions were held constant, except as required for the scenarios. Costs reported in this analysis are reported in constant 1994 dollars to maintain consistency with the 95 TSLCC.

The 95 TSLCC baseline assumed use of Multi-Purpose Canisters (MPCs) for disposal of commercial SNF. HLW is assumed to be disposed of in waste packages containing four standard canisters each. Current Civilian Radioactive Waste Management System (CRWMS) planning does not assume MPCs for SNF and the TWRS program is planning use of HMPCs for HLW. This analysis maintains MPCs for SNF disposal, and shipment and disposal of individual HLW canisters in waste packages to maintain consistency with the 95 TSLCC. Future TSLCC reports will update the CRWMS baseline. A qualitative discussion of the impacts of an HMPC is provided in Section 4.

3.2 TWRS ALTERNATIVE SCENARIOS

Waste streams that minimized impact on repository capital costs were established for each alternative scenario. Delivery schedules were generated in discussion with the TWRS program to develop reasonable cases for evaluation of disposal costs without inordinate or unnecessary impact to the repository. Additional opportunity for optimization of total defense high level waste flows can result in capital cost reduction. Further improvement of waste stream flows was not possible within task schedule constraints. The schedules for emplacement of waste packages containing Hanford HLW are shown in Table 3-1.

Table 3-1 Waste Package Emplacement Schedule Assumptions for TWRS Alternative Scenarios

Year	All Scenarios	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Total Commercial SNF WP's	Hanford WP's	Total DHLW WP's	Hanford WP's	Total DHLW WP's	Hanford WP's	Total DHLW WP's	Hanford WP's	Total DHLW WP's
2010	53								
2011	117								
2012	204								
2013	315								
2014	422								
2015	435		435		435		435		435
2016	417		416		416		416		416
2017	429		428		428		428		428
2018	412	249	411	249	411	95	237	249	411
2019	399	50	399	49	398	19	368	49	398
2020	403	295	329	295	329	19	55	368	402
2021	404	309	343	309	343		34	369	403
2022	408	302	336	302	336		34	373	407
2023	404	291	325	291	325		34	369	403
2024	407	292	326	292	326		34	372	404
2025	400	300	338	300	338		35	368	399
2026	397	306	333	306	333		27	371	398
2027	415	320	347	320	347		27	387	414
2028	403	317	344	317	344		27	373	400
2029	415	328	355	20	41		27	388	415
2030	448	355	382		22		22	390	417
2031	410	342	342					409	409
2032	425	392	391					425	425
2033	422	351	355					419	419
2034	425	360	360					424	424
2035	414	380	380					415	415
2036	421	211	211					426	425
2037	395							394	394
2038	413							412	412
2039	419							418	418
2040	257							528	528
2041								814	814
2042								814	814
2043								814	814
2044								814	814
2045								814	814
2046								814	814
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2067								814	814
2068								814	814
2069								814	814
2070								814	814
2071								814	814
2072								814	814
2073								814	814
2074								814	814
2075								28	28
TOTAL	18,210	5,350	7,376	3,050	5,176	133	2,259	36,400	38,326

3.3 METHODOLOGY

3.3.1 Defense Share Methodology

The Nuclear Waste Policy Act as Amended requires full cost recovery from both defense and commercial users of the repository, with no cross-subsidization of program costs. Commercial SNF disposal costs are paid from receipts from a ratepayer fee charged on electricity generated and sold from nuclear power plants. Defense costs are paid from Defense Nuclear Waste Disposal appropriations. Costs are allocated among program participants according to a methodology published in the Federal Register (reference 4). This methodology has been applied to each case to estimate a total defense share for each scenario.

The methodology collects direct costs, allocates certain indirect costs based on piece count and areal dispersion factors, and then assigns remaining costs based on factors derived from relative direct and allocated costs. *Assignable direct costs* are incurred solely for the disposal of either HLW or SNF and are allocated in total to either the civilian program, defense program, or to West Valley. *Assignable common variable costs* are allocated among the civilian, defense, and West Valley programs by appropriately applying cost sharing factors, piece count, and areal dispersion to the specific individual cost accounts. *Common unassigned costs* are the remaining costs that cannot be either directly allocated or allocated on the basis of the cost sharing factors described above. Unassigned costs comprise a significant portion of the total system cost due to high development and evaluation costs compared to construction and operation.

The methodology was not developed to evaluate extreme variations from the base case such as the very low piece counts in Scenario 3 or the disproportionately large waste package sizes in Scenario 4. For these reasons, share allocation methodology may require modification if such alternatives are pursued, and respective cost shares may change as a result. This bias in methodology due to application of a method for a point estimate to a significant case variation tends to understate costs for Scenario 3, and may misrepresent costs for Scenario 4. A lesser degree of change also may be required for Scenario 2 to account for change in relative size of waste packages.

3.3.2 Mined Geologic Disposal System (MGDS) Cost Estimates

Analyses of Scenarios 1, 2, and 3 were able to maintain 95 TSLCC design assumptions for the repository thermal loading approach and emplacement of HLW waste packages in the space between hot SNF waste packages. Scenario 4 requires assumption of development of additional area(s) at the repository with a low thermal load setting which is dedicated to excess Hanford HLW. The HLW quantity exceeds the number of available openings in the high thermal load repository. Detailed engineering evaluations were not performed for this study. Waste package design verified sufficient corrosion allowances for the defense high level waste packages for emplacement in a low thermal setting.

MGDS estimates were developed for each case using TSLCC models adjusted for changes in throughput capacity and additional underground excavation where required. Waste package dimensions and cost were developed consistent with the 95 TSLCC and 96 Advanced Conceptual Design bases. Repository estimates are based on the waste stream shown previously in Table 3-1, and are consistent with 95 TSLCC assumptions.

3.3.3 Transportation Cost Estimates

New HLW transportation cask designs would be required to support Scenarios 2, 3 and 4. An estimate has been made of changes required to the HLW cask design used in the 95 TSLCC to accommodate different size canisters compatible with the Hanford TWRS scenarios. No new thermal, mechanical, or radiological analyses were performed. The 95 TSLCC assumes a HLW rail cask with a capacity of five standard HLW canisters. The required cask types were scaled from the notional cask design used in the 95 TSLCC. Capacity of the transportation casks for the long canisters in Scenarios 2 and 3 was determined as four long canisters each, to meet national rail transportation system limits, assuming similar shielding as the TSLCC cask design basis (reference 5). This may be conservative. Design studies to optimize shielding for the low radiologic activities of HLW may permit a reduction in shielding which could increase the capacity for long canisters to five canisters. Scenario 4 was based on one very large canister per transportation cask. Capital costs for alternative casks were estimated based on data for the BR-100 rail cask. Shipping and related costs were estimated using the same methods as the 95 TSLCC.

3.3.4 Development and Evaluation and Other Program Costs

Development and evaluation (D&E) costs and other program costs were evaluated and are assumed to be essentially constant for Scenarios 1, 2 and 3. An addition for alternative cask development was identified for Scenarios 2 and 3.

Significant increases in development and evaluation, and other program costs would occur for Scenario 4 due to additional repository area characterization and licensing, and significant extension of waste acceptance and transportation operations. Costs were estimated based on notional schedules and throughput rates consistent with the capacity required for the high thermal loading repository. Estimates are based on 95 TSLCC costs for similar activities associated with a repository in the primary area, with a high thermal loading setting. Estimates for the new scope related to the Hanford only repository areas assume cost efficiencies gained from experience during the first phase of development and operations.

4. ANALYSIS

4.1 DEFENSE SHARE OF TOTAL SYSTEM COSTS

4.1.1 Results Summary

A summary of defense disposal costs for the TWRS alternatives is shown in Tables 4-1, 4-2, 4-3, and 4-4. From lowest to highest total system and defense share costs, the alternatives are ranked Scenario 3, 95 TSLCC Base Case, Scenario 2, Scenario 1, and Scenario 4. Scenario 3 reduces overall program costs by approximately $0.5B in 1994 dollars. Variation from the total system life cycle cost ranges from -1 percent to +6 percent for the first three alternatives. Scenario 4 doubles the total system disposal costs, and shifts the program from a civilian repository that is less than approximately 25 percent defense to a repository that is almost 75 percent defense on a total emplaced waste package count basis.

4.1.2 Limits of Analysis

Results should support evaluation of alternatives for TWRS but should not be taken as final estimates of the defense share. The estimates are consistent with the 95 TSLCC. Estimates are at a scoping level of detail, scaled from TSLCC data and estimated through use of TSLCC models. Results are not based on engineering studies of the specific alternatives and do not represent detailed point estimates. As noted in Section 3, the cost sharing methodology is limited in its application to cases which differ significantly from the base case. In particular, defense share is understated by the methodology for Scenario 3, and to lesser degrees for Scenarios 4 and 2, respectively. In addition, future TSLCC updates are required to incorporate developing changes to the CRWMS. Disposal of DOE SNF, accommodation of a variety of utility cask/canister systems for commercial SNF, and changes in funding profiles are current changes which will have system impact and will affect costs and cost shares.

4.1.3 Direct Costs

Tables 4-1 through 4-4 provided estimates of total disposal system costs and total defense share allocations of disposal costs for each scenario, based on a consistent methodology. Defense share estimates include disposal of all planned HLW from Hanford, Savannah River, and Idaho National Engineering Laboratory. Estimates of direct costs for Hanford HLW compared to total defense HLW are provided in Table 4-5 for use in further allocation of program indirect costs among the various defense programs. The Federal Register cost allocation methodology estimates total defense share compared to civilian to ensure no cross-subsidization of defense and civilian programs but does not address allocations among defense programs.

Table 4-1 Summary of Civilian, Defense, and West Valley Allocation (In Millions of 1994 Dollars) Scenario 1

	COST ALLOCATIONS											
	TSLCC95				Scenario 1				Delta			
Category	Defense	WV	Civilian	Total	Defense	WV	Civilian	Total	Defense	WV	Civilian	Total
Development & Evaluation	2,756	46	9,717	12,520	4,128	40	8,353	12,521	1,372	(6	(1,364	1
Repository 1	2,817	47	7,932	10,796	4,868	47	7,652	12,566	2,050	0	(280	1,770
Transportation	434	10	1,846	2,290	667	9	1,838	2,515	233	(1	(8	225
MPCs	0	3	5,516	5,519	0	3	5,516	5,519	0	0	0	0
Waste Acceptance	236	5	1,005	1,246	331	5	912	1,247	95	(1	(93	1
MRS	N/A				N/A				N/A			
Benefits	109	2	306	417	162	2	254	417	53	(0	(52	(0
PETT	80	1	226	308	119	1	188	308	39	(0	(39	(0
Total	$6,432	$114	$26,550	$33,096	$10,274	$106	$24,712	$35,093	$3,842	($8	($1,838	$1,997
Percentage %	19.43%	0.34%	80.22%	100.00%	29.28%	0.30%	70.42%	100.00%	9.84%	-0.04%	-9.80%	0.00%

Note: Totals may not add due to independent rounding

Table 4-2 Summary of Civilian, Defense, and West Valley Allocation (In Millions of 1994 Dollars)

Scenario 2

Category	COST ALLOCATIONS											
	TSLCC95				Scenario 2				Delta			
	Defense	WV	Civilian	Total	Defense	WV	Civilian	Total	Defense	WV	Civilian	Total
Development & Evaluation	2,756	46	9,717	12,520	3,482	52	9,010	12,543	726	5	(708)	23
Repository 1	2,817	47	7,932	10,796	3,816	56	7,986	11,858	998	9	54	1,061
Transportation	434	10	1,846	2,290	754	13	1,832	2,598	320	3	(15)	308
MPCs	0	3	5,516	5,519	0	3	5,516	5,519	0	0	0	0
Waste Acceptance	236	5	1,005	1,246	362	6	879	1,247	126	1	(126)	1
MRS	N/A				N/A				N/A			
Benefits	109	2	306	417	134	2	281	417	25	0	(26)	(0)
PETT	80	1	226	308	99	1	207	308	19	0	(19)	(0)
Total	$6,432	$114	$26,550	$33,096	$8,646	$133	$25,711	$34,490	$2,214	$19	($839)	$1,394
Percentage %	19.43%	0.34%	80.22%	100.00%	25.07%	0.39%	74.55%	100.00%	5.63%	0.04%	-5.67%	0.00%

Note: Totals may not add due to independent rounding

Table 4-3 Summary of Civilian, Defense, and West Valley Allocation (In Millions of 1994 Dollars) Scenario 3

Category	COST ALLOCATIONS TSLCC95 Defense	WV	Civilian	Total	Scenario 3 Defense	WV	Civilian	Total	Delta Defense	WV	Civilian	Total
Development & Evaluation	2,756	46	9,717	12,520	1,648	57	10,838	12,543	(1,108)	11	1,121	23
Repository 1	2,817	47	7,932	10,796	1,554	53	8,719	10,326	(1,263)	7	787	(470)
Transportation	434	10	1,846	2,290	416	16	1,852	2,283	(18)	6	5	(7)
MPCs	0	3	5,516	5,519	0	3	5,516	5,519	0	0	0	0
Waste Acceptance	236	5	1,005	1,246	227	9	1,011	1,247	(9)	3	6	1
MRS	N/A				N/A				N/A			
Benefits	109	2	306	417	63	2	352	417	(46)	0	46	(0)
PETT	80	1	226	308	46	2	260	308	(34)	0	34	(0)
Total	$6,432	$114	$26,550	$33,096	$3,954	$141	$28,549	$32,643	($2,478)	$27	$1,999	($453)
Percentage %	19.43%	0.34%	80.22%	100.00%	12.11%	0.43%	87.46%	100.00%	-7.32%	0.09%	7.23%	0.00%

Notes: Share methodology understates defense share of unassigned costs due to extremely low piece counts. Actual share will be higher.
Totals may not add due to independent rounding

Table 4-4 Summary of Civilian, Defense, and West Valley Allocation (In Millions of 1994 Dollars) Scenario 4

Category	COST ALLOCATIONS											
	TSLCC95				Scenario 4				Delta			
	Defense	WV	Civilian	Total	Defense	WV	Civilian	Total	Defense	WV	Civilian	Total
Development & Evaluation	2,756	46	9,717	12,520	12,866	26	3,497	16,389	10,110	(21	(6,220	3,869
Repository 1	2,817	47	7,932	10,796	31,221	61	5,317	36,599	28,404	14	(2,616	25,802
Transportation	434	10	1,846	2,290	3,527	14	1,838	5,379	3,094	4	(9	3,089
MPCs	0	3	5,516	5,519	0	3	5,516	5,519	0	0	0	0
Waste Acceptance	236	5	1,005	1,246	957	4	498	1,459	721	(2	(507	213
MRS	N/A				N/A				N/A			
Benefits	109	2	306	417	375	1	64	440	267	(1	(243	23
PETT	80	1	226	306	316	1	54	370	235	(1	(173	62
Total	$6,432	$114	$26,550	$33,096	$49,262	$108	$16,784	$66,154	$42,830	($6	($9,766	$33,058
Percentage %	19 43%	0 34%	80 22%	100 00%	74 47%	0 16%	25.37%	100 00%	55.03%	-0.18%	-54.85%	0.00%

Notes: Scenario significantly in excess of repository planning basis Requires assumptions which increase uncertainty of estimate.
Scenario outside methodology validity for piece counts and disproportional waste package size.
Totals may not add due to independent rounding

Table 4-5 Summary of Direct Disposal Costs for TWRS Alternatives (Millions of 1994$)

Category	1995 TSLCC		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Hanford	Total Direct Defense	Hanford	Total Direct Defense	Hanford	Total Direct Defense	Hanford	Total Direct Defense	Hanford	Total Direct Defense
Repository										
Waste Packages	734	1,344	1,708	2,317	1,270	1,880	55	664	18,053	18,662
Emplacement	117	217	267	367	143	244	10	111	1,737	1,838
Transportation										
Shipping & Security (1)	123	264	294	435	204	345	15	156	2,241	2,382
Cask Purchases/Decom.	46	136	92	181	268	357	142	231	785	874
Total Direct	1,021	1,961	2,360	3,301	1,885	2,825	222	1,162	22,816	23,756

(1) Includes 180(c) costs

(2) Totals may not add due to independent rounding

4.2 COST ESTIMATE SENSITIVITIES

4.2.1 Repository

A summary of total repository costs is provided in Table 4-6 for the 95 TSLCC base case and the 4 TWRS scenarios, with a cost breakout by major cost element. The estimates are a subset of the total system costs shown in Tables 4-1 through 4-4. The values represent total repository costs for each scenario, without regard to allocation of costs to defense or civilian cost accounts. This data provides insight into the effect of each scenario on total system costs. For example, repository development and evaluation is constant for Scenarios 1, 2, and 3, but increases by $2.3 billion (94$s) for Scenario 4. The increase is a result of the cost of characterization of additional area, and associated licensing and development. This contrasts with defense shares of total D&E shown previously in Tables 4-1 through 4-4, which vary by scenario, dependent on sharing factors based on direct and assignable costs discussed in Section 3.3.1.

Major components of the repository estimate include waste package costs, the quantity of canisters, surface facility capital and operating costs, subsurface capital and operating costs, Nevada transportation capital and operating costs, and performance confirmation operations. Operating costs are driven primarily by years of emplacement. Capital costs are driven by either requirements for additional area or throughput capacity. Table 4-7 summarizes repository cost drivers. It identifies cost changes as a ratio relative to the 95 TSLCC for each of the Hanford TWRS scenarios.

4.2.2 Transportation

Transportation operations costs are primarily direct costs accrued by specific shipments. The defense share of transportation operations for the alternatives is most affected by the number of canisters per transportation cask, quantities of shipments, and cask fleets required to support the shipping schedule. Mileages are addressed in the modeling of costs but are constant for all Hanford alternatives.

The defense shares of transportation operations increased by 54 percent for Scenario 1, 74 percent for Scenario 2, and 713 percent for Scenario 4. Scenario 1 had a high number of shipments but these costs were offset in part by reduced cask fleet costs due to the commonality of casks for all DHLW. Cask costs increased only 34 percent to support the increased operational tempo. Scenario 2 had fewer shipments than Scenario 1, but defense cask fleet costs increased 163 percent due to multiple cask types and high system throughputs. Scenario 4 increases are due to the extremely large number of shipments over a long period of time, and dedicated transportation fleets. Scenario 4 cask costs increased 549 percent. Scenario 3 costs decreased by 4 percent overall. Savings that resulted from fewer trips were offset by a 67 percent increase in cask fleet costs due to use of different types for DHLW. There may be approaches to reduce this impact by adjusting the assumed delivery schedules.

Table 4-6 Repository Cost Summary (millions of 94$s)

Cost Category	1995 TSLCC	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Rail Spur & Performance Confirmation	926	926	926	926	1,159
Surface Facilities	3,312	3,918	3,774	3,607	7,681
Subsurface Facilities	2,748	2,897	2,775	2,642	6,491
Waste Package	3,876	4,786	4,354	3,133	21,145
Development and Evaluation (Yucca Mountain only)	6,532	6,532	6,532	6,532	8,819
Totals (1)	17,394	19,059	18,361	16,840	45,295

(1) Totals may not add due to independent rounding

Table 4-7 Repository Cost Drivers

Source of Change		Ratio (scenario/95 TSLCC)
Waste Package		
Unit cost due to glass pour canister sizes		
	Scenario 1	1.00
	Scenarios 2,3	1.41
	Scenario 4	1.67
Waste Package quantity variation		
	Scenario 1	1.71
	Scenario 2	1.40
	Scenario 3	0.50
	Scenario 4	13.69
Surface Facilities		
Capital costs		
	Scenarios 1,2,3	1.19
	Scenario 4	1.28
Operating labor		
	Scenario 1	1.2
	Scenario 2	1.15
	Scenario 3	1.08
	Scenario 4	2.59
Subsurface Facilities		
Capital and operating affected by excavation lengths and waste package quantities		
	Scenario 1	1.05
	Scenario 2	1.01
	Scenario 3	0.96
	Scenario 4	2.36

4.2.3 Development and Evaluation and Other Program Costs

4.2.3.1 Scenarios 1, 2, and 3

Development and evaluation (D&E) costs and other program costs were evaluated and are assumed to be essentially constant for Scenarios 1, 2 and 3. The only change identified for Scenarios 2 and 3 is an addition for alternative cask development.

4.2.3.2 Scenario 4

In Scenario 4, repository D&E would increase to characterize additional repository areas required to accommodate excess Hanford HLW which can not be emplaced within the primary area. Characterization is assumed to start in 2026, followed by license application in 2032 and construction authorization in 2035. Costs are assumed to be approximately 50 percent of 95 TSLCC costs for characterization and licensing of the repository primary area. Repository surface operations and emplacement, along with supporting transportation and waste acceptance operations, would continue 35 years after completion of emplacement of all commercial SNF and other HLW. Allowing for a caretaker period ending 50 years after start of emplacement in the additional area, program duration would be extended from the 95 TSLCC case completion in 2071 to closure and decommissioning in 2102.

Other D&E, waste acceptance operations, and other program costs were adjusted to the increased scope. These activities also assume efficiencies over similar activities in development of the initial repository primary area, and make adjustments for system simplification since there is only one source of wastes to be disposed of in the Hanford HLW only period of operations.

4.3 EVALUATION OF ALTERNATIVES

The following identifies quantitative and qualitative discriminators for the scenarios determined in the course of this cost analysis for each alternative. This analysis does not take in to account other additional wastes such as DOE SNF which may be required to be emplaced in a repository, or potential variation in HLW canister quantities from other sites. Technical feasibility and environmental effects of disposal are not within the scope of this study and are not addressed.

4.3.1 Scenario 1

Scenario 1 significantly increases the quantity of HLW waste packages over the 95 TSLCC base case. The 95 TSLCC design approach of emplacing HLW waste packages in spaces between the higher thermal output SNF packages requires matching the incoming HLW and SNF waste stream. A disadvantage of this alternative is that it requires an efficient use of most available spaces between SNF packages. Defense HLW waste packages fill approximately 74 percent of the available spaces between SNF waste packages in the period from 2015 through 2040. This could limit growth capacity in the primary area of the repository. This analysis also does not take in to account other additional wastes such as DOE SNF which may be required to be emplaced in a repository, or potential variation in HLW canister quantities from other sites. For these reasons, this alternative could compete with other wastes being considered for disposal. A more efficient (lower quantity of HLW packages) utilization of repository space would be preferred. This alternative is ranked third in terms of overall cost.

4.3.2 Scenario 2

Scenario 2 is closest to the base case in terms of the number of canisters and repository utilization, given Hanford expectations of higher glass production identified in reference 1 (14,260 m^3 vs. 6,100 m^3 assumed for TSLCC). It is a cost effective alternative and is compatible with the design concepts utilized in the 95 TSLCC. Some modification to cost share methodology may be required to account for disproportionate changes in waste package size, however the methodology bias is much less than for Scenario 3.

4.3.3 Scenario 3

Scenario 3 is a favorable alternative from standpoint of maximizing the efficient use of repository capacity. This alternative has the lowest overall defense waste disposal cost, and reduces total disposal program costs slightly. The cost sharing methodology requires modification to achieve legal requirements for full cost recovery as noted in the discussions in Section 3.3.1 above. The low piece counts of this scenario fall outside the validity of the computational method. Following such adjustment, costs for this alternative would increase, however this would still be the lowest cost alternative from the standpoint of disposal.

4.3.4 Scenario 4

Scenario 4, a no separations alternative, is not preferred from a disposal standpoint. Scenario 4 far exceeds other alternatives in total costs for disposal. This alternative requires substantial disposal area beyond what is being characterized by the Civilian Radioactive Waste Management Program. Scenario 4 would require characterization of secondary areas in addition to the primary area being characterized, suitability determination of the area, and associated licensing of a Hanford only section of the repository. It would require an alternate thermal strategy from that being planned for the repository. Seventy six percent of the Hanford wastes would require emplacement in the additional areas in a low thermal setting, following emplacement of the first twenty four percent of the Hanford HLW and all other HLW with all the available SNF in a high thermal setting in the primary area of the repository. This would require a license update for additional area in an alternate thermal setting. The requirement for both high and low thermal loading areas in Scenario 4 would complicate the licensing process. This is in contrast to the 95 TSLCC assumption of emplacement of all HLW with SNF in the primary area in a high thermal loading setting. Excess quantities of Hanford HLW may exceed available areas in the repository.

Disposition of remaining HLW would not be decided until DOE makes a recommendation on the need for a second repository, required by the NWPAA to be in the period from 2007 to 2010.

The cost sharing methodology may require modification to achieve legal requirements for full cost recovery as noted in the discussions in Section 3.3.1 above. The very high piece counts and large relative size of waste packages in this scenario fall outside the validity of the computational method. Further, uncertainties due to Scenario 4 assumptions may result in delays which could require prolonged on-site storage of excess canisters at Hanford. Uncertainties in assumptions also may increase disposal costs for this scenario.

4.4 QUALITATIVE IMPACTS OF USE OF HANFORD MULTI-PURPOSE CANISTER

4.4.1 Repository

Use of an HMPC which satisfies disposal requirements would result in a small cost saving at the repository for Scenarios 1, 2, and 3. In each case, HLW canisters are already planned to be disposed of in waste packages containing 4 canisters each, as is planned for the MPC. An HMPC would simplify surface facility handling operations. Repository cost savings would be small if any.

4.4.2 Transportation

The HMPC being considered in current TWRS planning is most analogous to Scenario 2 in this analysis. Use of an HMPC would have negligible effect on transportation for Scenario 2, which assumes a HLW transportation cask with a capacity of four long canisters each. Shipping costs would be reduced slightly due to a lower empty weight for return shipments because any basket structure to hold the canisters is part of the HMPC. Cask capital costs would be lower due to absence of the basket structure and reduction in shielding thickness to account for shielding provided by the HMPC canister wall.

The efficiency of an HMPC for Scenario 3 would depend upon the availability of suitable casks required for other purposes. Acquisition of dedicated casks would not be cost effective.

Use of an HMPC for Scenario 1 would require development of alternative transportation casks if not developed for other requirements, and would increase the number of shipments by 25 percent due to the capacity change of five canisters per cask to four.

An HMPC would have no effect on transportation for Scenario 4 since these very large canisters would be transported one per cask and there is no basket in either case.

REFERENCES

1. U.S. Department of Energy, *Request for Repository Disposal Fee Estimates for the Hanford Tank Waste Remediation System (TWRS) Environmental Impact Statement*, letter Ser WDD:PL 96-WDD-069 of Jun 7, 1996.

2. U.S. Department of Energy, *Analysis of the Total System Life Cycle Cost for the Civilian Radioactive Waste Management Program* (DOE/RW-0479), September, 1995.

3. Nuclear Waste Policy Amendments Act of 1987, Pub. L. No. 100-203, December, 1987

4. U.S. Department of Energy, "Civilian Radioactive Waste Management; Calculating Nuclear Waste Fund Disposal Fees for Department of Energy Defense Program Waste", pp. 31508-31524, *Federal Register*, Vol. 52 No. 161, August 20, 1987.

5. Jones, Robert H. and Nickell, Robert E., *Final Report, MRS-to-Repository Transportation System Design Characterization and Capacity Study*, Los Gatos, CA, December, 1989

RL-F-1325.5# DEF012
(04/93)

United States Government

Department of Energy

memorandum

Richland Operations Office

DATE: JUN 07 1996

REPLY TO
ATTN OF: WDD:PL 96-WDD-069

SUBJECT: REQUEST FOR REPOSITORY DISPOSAL FEE ESTIMATES FOR THE HANFORD TANK WASTE REMEDIATION SYSTEM (TWRS) ENVIRONMENTAL IMPACT STATEMENT (EIS)

TO: Ronald A. Milner, Director
Office of Program Management
and Integration, RW-30, HQ

References:

1. Office of Civilian Radioactive Waste Management Report, "Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program," DOE-RW-0479, dated September 1995.

2. Memorandum from R. A. Milner, HQ, to J. Kinzer, RL, "Evaluation of Hanford Longer High-Level Waste Product Canister Option for Acceptance by the Civilian Radioactive Waste Management System," dated April 5, 1996.

TWRS urgently requests support from RW concerning the estimated costs for disposal of defense High-Level Waste (HLW) from Hanford in order to complete the final TWRS EIS. Disposal costs in the draft TWRS EIS were initially estimated by extrapolating data from Reference 1.

In order to address recent comments on the draft EIS, more rigorous cost estimates based on application of RW's disposal cost methodology are needed for four TWRS alternative scenarios, which are defined in Attachment 1. These scenarios include use of a fifteen-foot long canister (Reference 2), as well as incorporation of the results of a recently completed probabilistic estimate of the quantity of borosilicate glass expected from the reference HLW pretreatment and vitrification processes. Attachment 2 provides additional technical data, requested by your staff, to assist them in evaluating these scenarios.

The scheduled date for release of the TWRS EIS is July 31, 1996. To achieve this date, the revision must be completed by June 28, 1996. Based on recent discussions with members of your staff, it is our understanding that RW could provide informal input for the four scenarios by June 18, 1996. A formal, referenceable memorandum summarizing the estimates should be transmitted by June 21, 1996. These dates are the latest that will allow the TWRS Program to meet the schedule for issuing the TWRS EIS by the end of July.

Choon Quan of your staff has advised us that RW contractor staff are available to respond to this request. It is understood that RW is willing to proceed with this study pending satisfactory resolution of funding considerations.

Thank you very much for your prompt consideration of this very important request. If you have any questions, please contact me on (509) 376-7591 or Phil E. LaMont of my staff on (509) 376-6117.

ORIGINAL SIGNED BY
Jackson Kinzer, Assistant Manager
Office of Tank Waste Remediation System

Attachments (2)

cc w/attachs:
S. Cowan, EM-30
T. Harms, EM-38
M. Hunemuller, EM-38
C. Myler, EM-38
C. Conner, RW-35
J. Carlson, RW-37
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DEFENSE WASTE DISPOSAL FEE ESTIMATES NEEDED BY HANFORD FOR THE TANK WASTE REMEDIATION SYSTEM ENVIRONMENTAL IMPACT STATEMENT

The Hanford Tank Waste Remediation System (TWRS) program is on an aggressive schedule for completion of its Environmental Impact Statement (EIS) for the disposal of Hanford's tank wastes. In order to complete the required definition and evaluation of major alternatives, preliminary estimates of the repository fees for defense HLW disposal for the four (4) scenarios described below are needed by 6/14/96. An approved referenceable memorandum transmitting these disposal fee estimates is needed no later than June 21, 1996.

RW has provided a baseline allocated cost estimate for disposal of 18,046 defense HLW "standard" 0.61m x 3.0m (0.62 m^3) canisters in a single repository as reported in DOE/RW-0479, "Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program". Starting with the TSLCC as a baseline, TWRS is requesting allocated defense HLW disposal fee estimates for the following scenarios as summarized in Table 1:

<u>Scenario 1</u>: Increase the estimated number of "standard" canisters for Hanford from 9,860 in the TSLCC to 23,000, which reflects current judgment of the most probable quantity of immobilized HLW (14,000 m^3) for the reference "enhanced sludge wash" process.

<u>Scenario 2</u>: Assume 12,200 "long" 0.61m x 4.5m canisters (1.17 m^3) for the most probable quantity of Hanford's HLW as described in Scenario 1.

<u>Scenario 3</u>: Assume 530 "long" canisters for 620 m^3 of HLW resulting from "extensive separations" pretreatment process.

<u>Scenario 4</u>: Assume 36,400 "very large" 1.68m x 5.03m canisters (10 m^3) for 364,000 m^3 HLW produced without any pretreatment.

Since the TSLCC included Multi-Purpose Canisters for commercial Spent Nuclear Fuel and for West Valley's HLW, but not for defense HLW, this cost component should be retained for the above calculations in order to ensure comparability with the TSLCC report. If the MPC cost component is not retained for the requested calculations, Table 7-1 in the TSLCC should be updated to delete the MPC.

The draft TWRS-EIS is based on placing the HLW canisters in a "Hanford Multi-Purpose Canister" (HMPC) for interim onsite storage and transfer to RW for disposal. Recognizing that defense HLW canisters were not placed in MPCs in the 1995 TSLCC, RW is requested to comment qualitatively on the disposal fee impact, if the HMPC concept were to be used. (NOTE: Cost of the HMPC is currently included in the cost of waste treatment at Hanford.)

It is requested that the disposal fee estimates be reported similarly to the TSLCC base case shown in Table 7-I of the TSLCC report and summarized as shown in Table 1.

TABLE 1 - REPOSITORY DISPOSAL FEE EVALUATION MATRIX

	Canister Size	Pretreat Process	Volume of Glass, m^3	Number of Hanford Canisters	Total No. of DHLW Canisters	Total Repository Cost	Allocated DHLW Share
Base Case (RW-0479)	0.61m D X 3.0 m	ESW[1]	6,100	9,860	18,046	$33.1 B	$6.43B
Scenario #1 (most probable volume)	0.61m D X 3.0m	ESW	14,260	23,000[2]	31,186	TBD by RW	TBD by RW
Scenario #2 (long canister)	0.61m D X 4.50m	ESW	14,260	12,200	20,386	TBD by RW	TBD by RW
Scenario #3 (minimum volume)	0.61m D X 4.50m	Extensive Separations[3]	620	530	8,716	TBD by RW	TBD by RW
Scenario #4 (very large canister)	1.68m D X 5.03m	No Pretreatment[4]	364,000	36,400	44,586	TBD by RW	TBD by RW

[1] Enhanced Sludge Wash (Caustic Leaching)--TWRS Technical Baseline for pretreatment of HLW sludges

[2] This value was judged to be the most probable volume of glass produced using the current TWRS flowsheet (memo, Taylor/Lang to Distribution, 4/29/96)

[3] Extensive Separations--Alternative pretreatment processes for HLW waste sludges

TECHNICAL DATA TO SUPPORT DISPOSAL FEE CALCULATIONS FOR TWRS-EIS

	Outer Diam., m	Length, m	Wall thickness, cm	Nominal Glass Volume, m^3	Total Nominal Weight, kg	Annual Production Rate, # of canisters
DWPF standard canister	0.61	3.00	1.0	0.62	2,200	15000[1]
TWRS standard canister	0.61	4.50	1.0	1.17	3,700	800[1] 75[2]
TWRS "very large" canister	1.68	5.03	2.5	10.0	29,700	2,200[3]

The total thermal output from all Hanford waste is 930 kW, indexed to December 2021 and assuming that the Cs and Sr capsule inventories are included in the glass. For purposes of evaluating the four (4) scenarios, it should be assumed that the thermal output is uniformly distributed among the number of canisters associated with each scenario, e.g. 1.8 kW per canister for Scenario 3.

The total equivalent Metric Tons Heavy Metal (eMTHM) for all Hanford tank waste is estimated to be 2,600, using the proposed methodology for calculating equivalency that is described in DOE-RL/87-04. Again it should be assumed for purposes of this exercise, that the EMTHM are uniformly distributed among the number of canisters associated with each scenario, e.g. 4.9 eMTHM per canister for Scenario 3.

[1] For Scenarios 1 and 2, the full-scale (Phase II) production rates are based on an instantaneous melter capacity of 12 MT/day at 60% total operating efficiency.

[2] For Scenario 3, the production rate is based on an instantaneous melter rate of 1 MT/day and a 60% TOE.

[3] For Scenario 4, the full-scale (Phase II) production rate is based on an instantaneous melter rate of 260 MT/day and a 60% TOE.

Full-scale production (Phase II) of HLW glass at Hanford is scheduled to start in 2013 and is to be completed no later than 2028 (Tri-Party Agreement milestone). Per earlier information from RW (Brandt, July 1993), Hanford's HLW canisters could be shipped starting in 2022 at a maximum rate of 800 canisters per year. However, the current planning base for the TWRS program is to provide interim on-site storage for all of the HLW canisters.

HLW Conc Data TWRS EIS

	Intermediate Separations Base Case (6/3/96)				
		Scenario 2 based on 12,200 Long Canisters (1.17 m^3)			
			Scenario 2		
			Curies/1.17 m^3		
	Radionuclide		canister		
	Inventory	glass			
		Ci/m^3			
	Am-241	1.38E+02	7.71E+00		
	Am-243	4.41E-02	2.47E-03		
	C-14				
	Cm-244	1.52E-01	4.55E-03		
	Cs-135	1.92E-01	1.16E-02		
	Cs-137	4.63E+04	2.85E+03		
	I-129				
	Ni-63	5.58E+00	2.16E+01		
	Np-237	9.23E-02	5.09E-03		
	Pu-238	1.42E+00	8.48E-02		
	Pu-239	3.46E+01	2.01E+00		
	Pu-240	8.77E+00	5.17E-01		
	Pu-241	9.82E+01	6.02E+00		
	Ra-226	3.56E-10			
	Ru-106	5.00E-05	2.93E-06		
	Sm-151		5.09E+01		
	Sn-126	8.24E-01	3.86E-02		
	Sr-90	7.05E+04	4.32E+03		
	Tc-99	4.24E+01	4.86E-01		
	Th-230	5.14E-08	3.16E-09		
	U-233	2.43E-08	9.25E-07		
	U-234	4.46E-07	1.62E-05		
	U-235	6.32E-02	1.62E-03		
	Zr-93		3.16E-01		
	Total (m3)	1.43E+04			
Note: Curies from decay daughter products not included					
Radionuclides reflect decay to 12/31/99					

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Extensive Separations alternative (6/3/96)						
	volume based on 530 long canisters at 1.17 m^3 (620 m^3 of HLW)					
						Scenario 3
		Extensive Separations Data Package values				
		Radionuclide Inventor		HLW Glass		Curies/1.17m^3
				Base Case (A-1)		canister
				Ci/m3		
		Am-241		1.67E+02		1.96E+02
		Am-243		5.35E-02		6.26E-02
		C-14				
		Cm-244		1.84E-01		2.15E-01
		Cs-135		2.33E-01		2.72E-01
		Cs-137		5.62E+04		6.57E+04
		I-129				
		Ni-63		6.78E+00		7.93E+00
		Np-237		1.12E-01		1.31E-01
		Pu-238		1.72E+00		2.01E+00
		Pu-239		4.20E+01		4.91E+01
		Pu-240		1.06E+01		1.24E+01
		Pu-241		1.19E+02		1.39E+02
		Ra-226		4.32E-10		5.05E-10
		Ru-106		6.06E-05		7.09E-05
		Sm-151				
		Sn-126		1.00E+00		1.17E+00
		Sr-90		8.56E+04		1.00E+05
		Tc-99		5.14E+01		6.02E+01
		Th-230		6.24E-08		7.30E-08
		U-233		2.94E-08		3.44E-08
		U-235		5.26E-05		6.15E-05
		U-238		1.22E-03		1.43E-03
		Zr-93		7.67E-02		8.98E-02
		total m3		6.20E+02		
Radionuclides reflect decay to 12/31/99						
Note: Curies from decay prod. not included						

HLW Conc Data TWRS EIS

Intermediate Separations Base Case (6/3/96)				
Scenario 1 based on 23,000 std size canisters of HLW				
			Scenario 1	
			Curies/0.62 m^3	
Radionuclide		HLW	canister	
Inventory		glass		
		Ci/m^3		
Am-241		6.59E+00	4.09E+00	
Am-243		2.11E-03	1.31E-03	
C-14				
Cm-244		3.89E-03	2.41E-03	
Cs-135		9.89E-03	6.13E-03	
Cs-137		2.44E+03	1.51E+03	
I-129				
Ni-63		1.85E+01	1.14E+01	
Np-237		4.35E-03	2.70E-03	
Pu-238		7.25E-02	4.50E-02	
Pu-239		1.71E+00	1.06E+00	
Pu-240		4.42E-01	2.74E-01	
Pu-241		5.14E+00	3.19E+00	
Ra-226				
Ru-106		2.50E-06	1.55E-06	
Sm-151		4.35E+01	2.70E+01	
Sn-126		3.30E-02	2.04E-02	
Sr-90		3.69E+03	2.29E+03	
Tc-99		4.15E-01	2.57E-01	
Th-230		2.70E-09	1.68E-09	
U-233		7.91E-07	4.90E-07	
U-234		1.38E-05	8.58E-06	
U-235		1.38E-03	8.58E-04	
Zr-93		2.70E-01	1.68E-01	
Total (m3)		1.43E+04		
Note: Curies from decay daughter products not included				
Radionuclides reflect decay to 12/31/99				

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No Separations Alternative (6/3/96)			
	20 wt % sodium oxide loading, 1.5 blending factor		
		Vitrification	Scenario 4
		Radionuclide	
		Concentration	Curies/10 m^3
		Curies /m^3	canister
Am-241		2.86E-01	2.86E+00
Am-243		9.12E-05	9.12E-04
Cm-244		3.24E-04	3.24E-03
Cs-137		9.58E+01	9.58E+02
Ni-63		7.39E-01	7.39E+00
Np-237		1.91E-04	1.91E-03
Pu-238		2.97E-03	2.97E-02
Pu-239		7.25E-02	7.25E-01
Pu-240		1.84E-02	1.84E-01
Pu-241		2.06E-01	2.06E+00
Ru-106		1.04E-07	1.04E-06
Sm-151		1.73E+00	1.73E+01
Sn-126		1.72E-03	1.72E-02
Sr-90		1.20E+02	1.20E+03
Tc-99		8.81E-02	8.81E-01
U-233		3.32E-08	3.32E-07
U-234		5.82E-07	5.82E-06
U-235		5.66E-05	5.66E-04
U-238		1.32E-03	1.32E-02
Zr-93		1.08E-02	1.08E-01
Total (m3)		3.64E+05	
Radionuclides reflect decay to 12/31/99			
Note: Curies from decay daughter products not included			